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Hashimoto

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(54) **SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURING THE SAME, CIRCUIT BOARD, AND ELECTRONIC INSTRUMENT**

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(51) **Int. Cl.⁷** **H01L 21/44; H01L 21/48; H01L 21/50**

(52) **U.S. Cl.** **438/118; 438/127; 438/108; 257/783; 257/787; 257/790**

(58) **Field of Search** **438/118, 127, 438/108; 257/783, 787, 778, 790**

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(57) **ABSTRACT**

A semiconductor chip is adhered to a substrate by using an adhesive, and a sealant is provided around the semiconductor chip, on a surface of the substrate on which the semiconductor chip is mounted. The adhesive is provided to reach a side surface of the semiconductor chip. The sealant is provided in a manner to expose an upper surface of the semiconductor chip and a part of the adhesive.

8 Claims, 4 Drawing Sheets

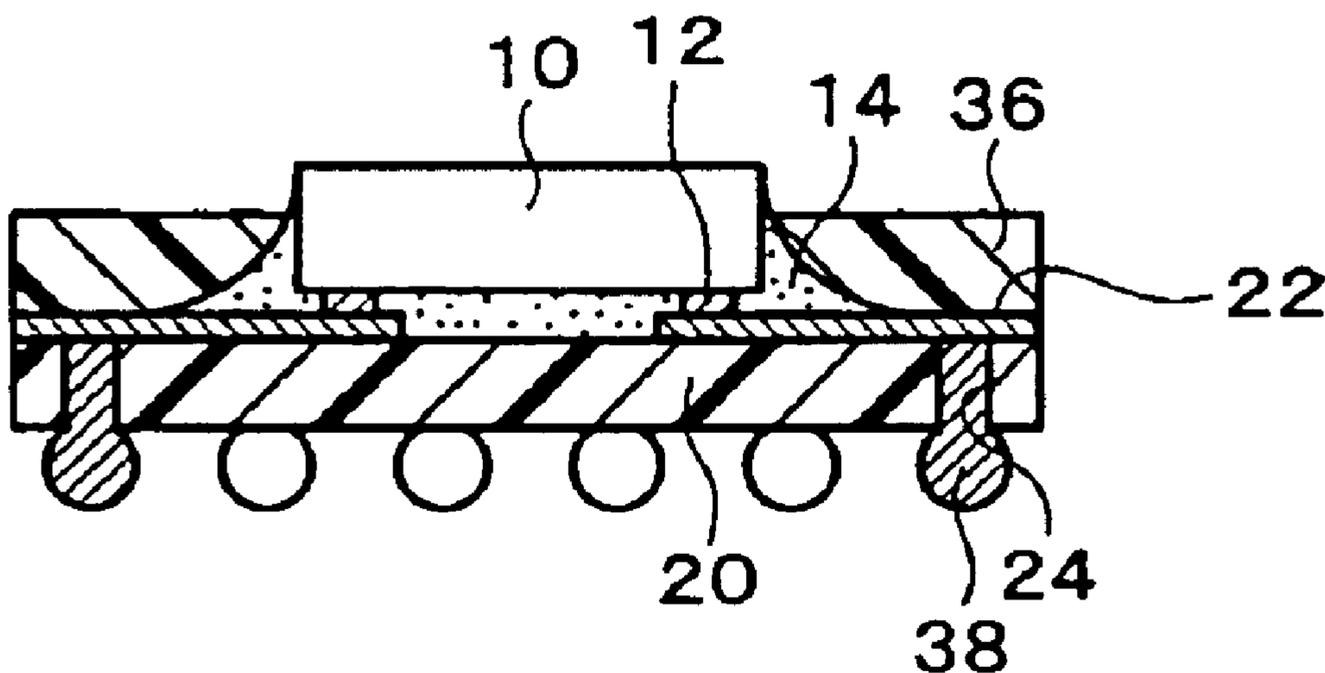


FIG. 1A

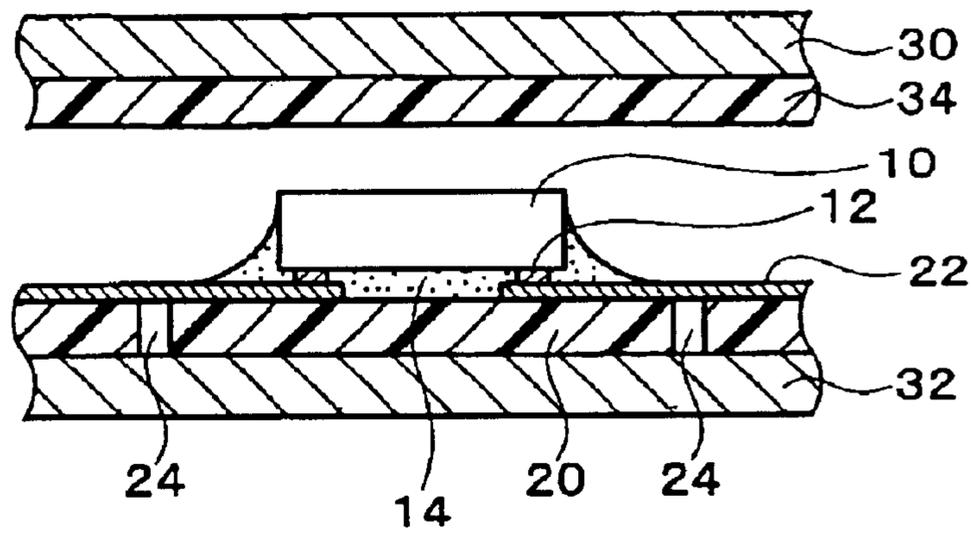


FIG. 1B

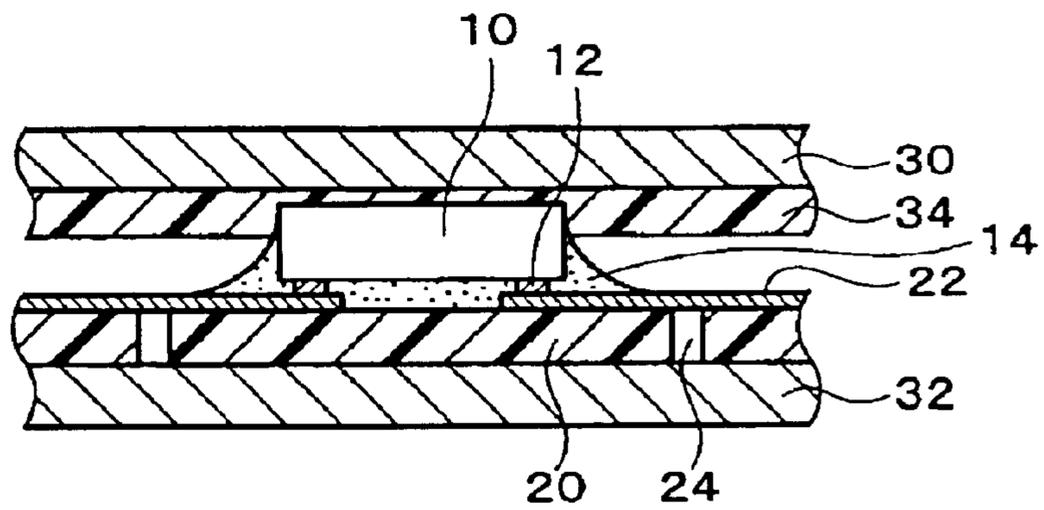


FIG. 1C

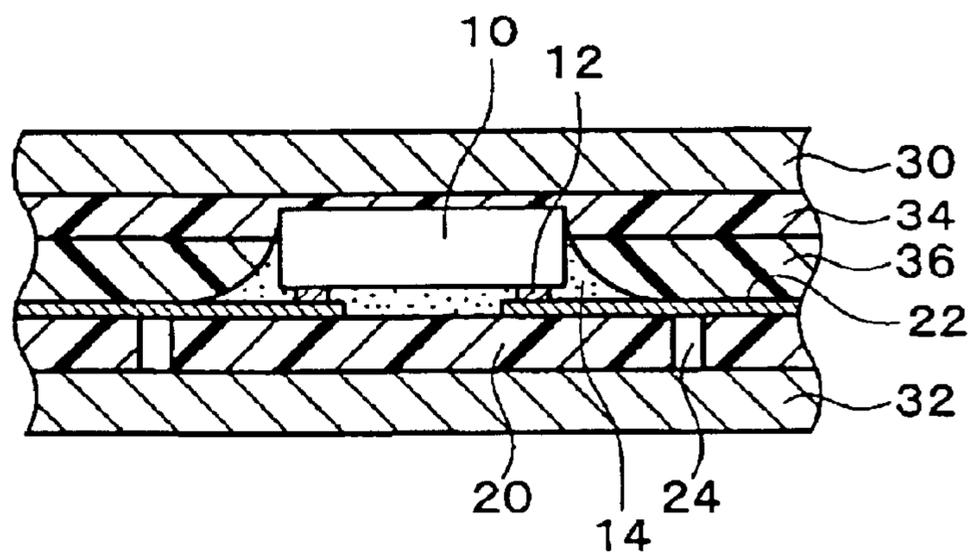


FIG. 2A

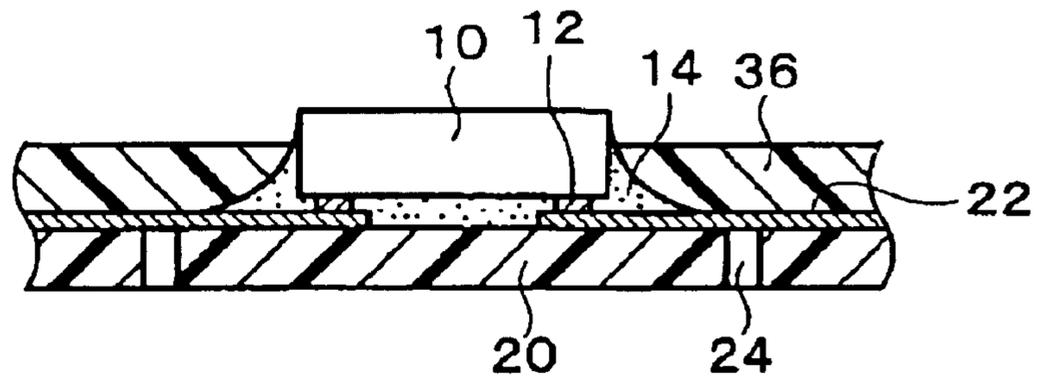


FIG. 2B

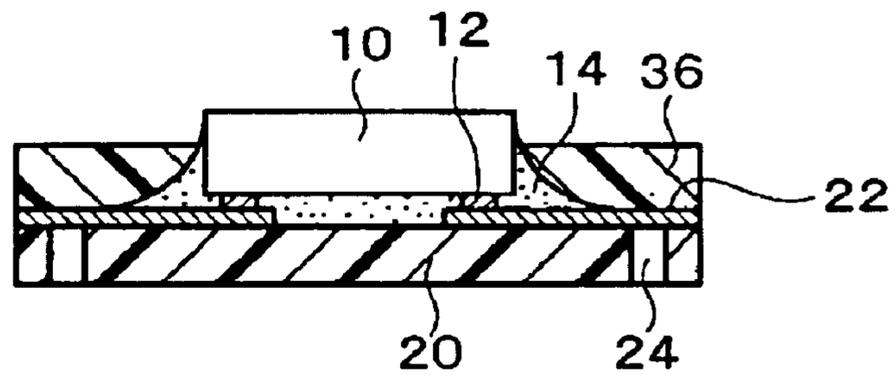


FIG. 2C

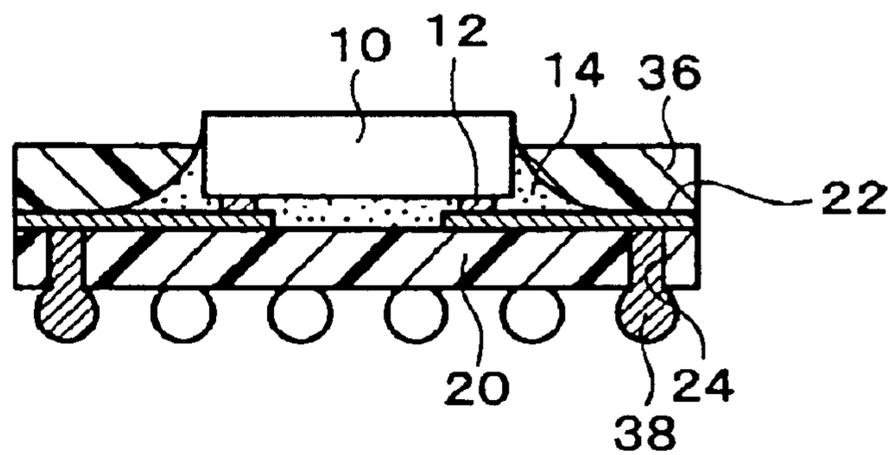


FIG. 3

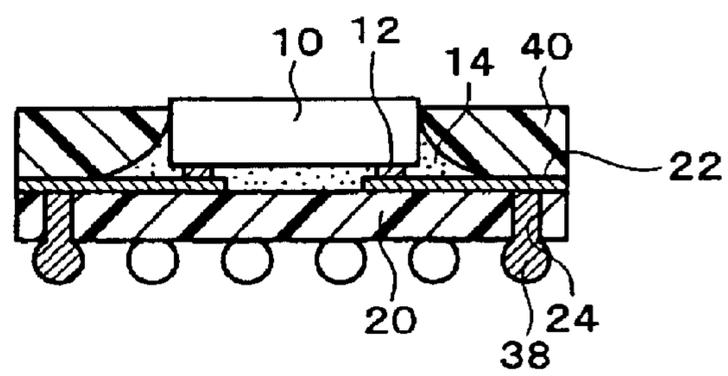


FIG. 4

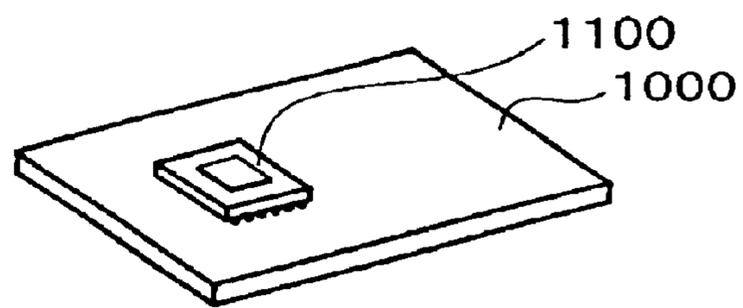


FIG. 5

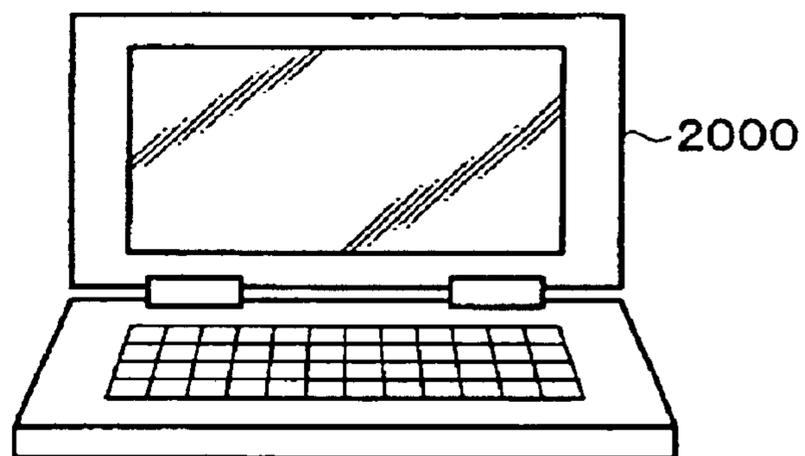
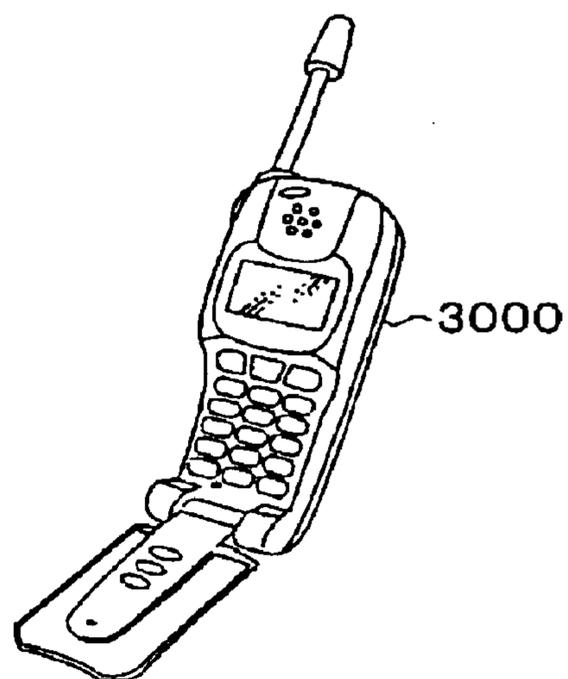


FIG. 6



SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURING THE SAME, CIRCUIT BOARD, AND ELECTRONIC INSTRUMENT

Japanese Patent Application No. 2002-65234, filed on 5
Mar. 11, 2002, is hereby incorporated by reference in its
entirety.

BACKGROUND OF THE INVENTION

The present invention relates to a semiconductor device 10
and method of manufacturing the same, to a circuit board,
and to an electronic instrument.

In a semiconductor device of the T-BGA (Tape-Ball Grid
Array) format, in order to ensure planarity of external
terminals (for example solder balls), a stiffener is attached to
the substrate for reinforcement. To attach the stiffener, an
expensive adhesive is required, and the stiffener itself is also
expensive, and equipment for the attachment is also
required. A resin-sealed semiconductor device is also
known. According to this type of conventional semiconduc-
tor device, since the semiconductor chip is completely
sealed by the mold resin, the heat dispersion is insufficient.

BRIEF SUMMARY OF THE INVENTION

A method of manufacturing a semiconductor device 25
according to an aspect of the present invention includes:

adhering a semiconductor chip to a substrate by using an
adhesive, and providing a sealant around the semiconductor
chip, on a surface of the substrate on which the semicon-
ductor chip is mounted,

wherein the adhesive is provided to reach a side surface
of the semiconductor chip, and

wherein the sealant is provided in a manner to expose an
upper surface of the semiconductor chip and a part of the
adhesive.

A method of manufacturing a semiconductor device
according to another aspect of the present invention
includes:

adhering a semiconductor chip to a substrate, and provid-
ing a sealant around the semiconductor chip, on a surface of
the substrate on which the semiconductor chip is mounted,

wherein a film is disposed on the semiconductor chip
adhered to the substrate, an upper die is disposed over the
film, a lower die is disposed under the substrate, the semi-
conductor chip and the substrate are sandwiched by the
upper die and lower die, the semiconductor chip is pressed
into the film, and the sealant is provided between the film
and the substrate.

A semiconductor device according to a further aspect of
the present invention includes:

a substrate;

a semiconductor chip bonded face-down to the substrate;

an adhesive adhering the substrate to the semiconductor
chip, and provided to reach a side surface of the semicon-
ductor chip;

and a sealant provided around the semiconductor chip, on
a surface of the substrate on which the semiconductor chip
is mounted,

wherein the sealant is provided in a manner to expose an
upper surface of the semiconductor chip and a part of the
adhesive.

A circuit board according to a still further aspect of the
present invention has the above mentioned semiconductor
device mounted on the circuit board.

An electronic instrument according to a yet further aspect
of the present invention has the above mentioned semicon-
ductor device.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIGS. 1A to 1C illustrate a method of manufacturing a
semiconductor device according to an embodiment of the
present invention;

FIGS. 2A to 2C illustrate the method of manufacturing a
semiconductor device of according to the embodiment of the
present invention;

FIG. 3 illustrates a modification of the method of manu-
facturing a semiconductor device of the embodiment of the
present invention;

FIG. 4 shows a circuit board according to an embodiment
of the present invention;

FIG. 5 shows an electronic instrument according to an
embodiment of the present invention; and

FIG. 6 shows an electronic instrument according to an
embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENT

Embodiments of the present invention may provide a
semiconductor device and method of manufacturing the
same, a circuit board, and an electronic instrument in which
a substrate is reinforced, and heat dispersion is high.

(1) A method of manufacturing a semiconductor device
according to an embodiment of the present invention
includes:

adhering a semiconductor chip to a substrate by using an
adhesive, and providing a sealant around the semiconductor
chip, on a surface of the substrate on which the semicon-
ductor chip is mounted,

wherein the adhesive is provided to reach a side surface
of the semiconductor chip, and

wherein the sealant is provided in a manner to expose an
upper surface of the semiconductor chip and a part of the
adhesive.

According to this embodiment of the present invention,
the substrate can be reinforced by the sealant. Since the
upper surface of the semiconductor chip (more precisely, the
surface opposite to the substrate) is exposed from the
sealant, the heat dispersion is excellent. Furthermore, since
the sealant is provided in a manner to expose a part of the
adhesive, water vapor can escape from the adhesive.

(2) In this method of manufacturing a semiconductor
device:

a film may be disposed on the semiconductor chip
adhered to the substrate, an upper die may be disposed over
the film, a lower die may be disposed under the substrate,
the semiconductor chip and the substrate may be sandwiched by
the upper die and lower die, the semiconductor chip may be
pressed into the film, and the sealant may be provided
between the film and the substrate.

By means of this, since the sealant is provided with the
film pressed into the semiconductor chip, the sealant is lower
than the semiconductor chip, water vapor can more easily
escape from the interface between the sealant and the
semiconductor chip. Since the semiconductor chip contacts
the film without directly contacting the upper die, chipping
and cracking can be prevented.

(3) In this method of manufacturing a semiconductor
device:

the semiconductor chip and the substrate may be sandwiched by the upper die and lower die in such a manner that a part of the adhesive is pressed into the film.

(4) A method of manufacturing a semiconductor chip according to another embodiment of the present invention includes:

adhering a semiconductor chip to a substrate, and providing a sealant around the semiconductor chip, on a surface of the substrate on which the semiconductor chip is mounted,

wherein a film is disposed on the semiconductor chip adhered to the substrate, an upper die is disposed over the film, a lower die is disposed under the substrate, the semiconductor chip and the substrate are sandwiched by the upper die and lower die, the semiconductor chip is pressed into the film, and the sealant is provided between the film and the substrate.

According to the embodiment of the present invention, the substrate can be reinforced by the sealant. Since the sealant is provided with the semiconductor chip pressed into the film, the upper surface of the semiconductor chip (more precisely, the surface opposite to the substrate) is exposed from the sealant, and moreover, the sealant is lower than the semiconductor chip. As a result thereof, the heat dispersion of the semiconductor device is improved, and water vapor can more easily escape from the interface between the sealant and the semiconductor chip. Since the semiconductor chip does not directly contact the upper die film, chipping and cracking can be prevented.

(5) In this method of manufacturing a semiconductor device:

the film may be more easily peeled from the sealant than from the upper die.

(6) A semiconductor device according to a further embodiment of the present invention includes:

a substrate;

a semiconductor chip bonded face-down to the substrate;

an adhesive adhering the substrate to the semiconductor chip, and provided to reach a side surface of the semiconductor chip;

and a sealant provided around the semiconductor chip, on a surface of the substrate on which the semiconductor chip is mounted,

wherein the sealant is provided in a manner to expose an upper surface of the semiconductor chip and a part of the adhesive.

According to this embodiment of the present invention, the substrate can be reinforced by the sealant. Since the upper surface of the semiconductor chip (more precisely, the surface opposite to the substrate) is exposed from the sealant, heat dispersion is excellent. Furthermore, since the sealant is provided to expose a part of the adhesive, water vapor can escape from the adhesive.

(7) A circuit board according to a still further embodiment of the present invention has the above mentioned semiconductor device mounted on the circuit board.

(8) An electronic instrument according to a yet further embodiment of the present invention has the above mentioned semiconductor device.

An embodiment of the present invention is now described with reference to the drawings. FIGS. 1A to 2C illustrate the method of manufacturing a semiconductor device of an embodiment of the present invention.

In this embodiment, a semiconductor chip **10** is adhered to a substrate **20**. The semiconductor chip **10** is an integrated circuit chip. The semiconductor chip **10** has a plurality of electrodes **12**. The electrodes **12** include pads and bumps

formed thereon. Between these pads and bumps may be further included a metal layer of under-bump metal or the like. On the surface of the semiconductor chip **10** on which the electrodes **12** are provided, a passivation film is formed, to avoid the electrodes **12**. The passivation film can be formed of, for example, SiO₂, SiN, polyimide resin, or the like.

The material of the substrate **20** may be either an organic or inorganic material, or may be a composite structure thereof. As a substrate formed of an organic material may be cited, for example, a flexible substrate formed of a polyimide resin. As a flexible substrate may be used an FPC (Flexible Printed Circuit), or a tape used in TAB (Tape Automated Bonding) technology. As a substrate formed of an inorganic material may be cited, for example, a ceramic substrate or glass substrate. As a composite structure of organic and inorganic materials may be cited, for example, a glass epoxy substrate. A substrate with a built-up multilayer construction having an insulating resin and an interconnecting pattern laminated, or a multilayer substrate having a plurality of substrates laminated may be used.

On the substrate **20**, an interconnecting pattern **22** is formed. The interconnecting pattern **22** can be formed by laminating any of copper, chromium, titanium, nickel, titanium-tungsten, gold, aluminum, nickel-vanadium, and tungsten, or by one layer of any. The interconnecting pattern **22** may be attached to the substrate **20** with an adhesive material (not shown in the drawings) interposed, to form a three-layer substrate. In this case, after applying photolithography, etching is carried out to form the interconnecting pattern **22**. Alternatively, the interconnecting pattern **22** may be formed on the substrate **20** without an adhesive, to constitute a two-layer substrate. For example, the interconnecting pattern may be formed by sputtering or the like, or an additive method of forming the interconnecting pattern **22** by plating may be applied. The interconnecting pattern **22** is preferably formed by plating with solder, tin, gold, nickel, or the like. If a metal plating is applied so as to form a eutectic, then the metal bond is more easily achieved, and this is desirable. On the interconnecting pattern **22**, bumps may be formed on bonding portions for other conductive elements. A part of the interconnecting pattern **22** may be formed as lands of greater area than the portions for interconnecting lines. These lands function to ensure the presence of adequate electrical connection portions.

In the substrate **20**, a through hole **24** is formed. The interconnecting pattern **22** may be formed to span the through hole **24**. The interconnecting pattern **22** may be formed to cover the opening of the through hole **24**. For example, the interconnecting pattern **22** may have a land which is larger than the opening of the through hole **24**, and this land may cover the through hole **24**. Alternatively, the interconnecting pattern **22** may have connection portions whose width is less than the diameter or width of the through hole **24**, and these connection portions may pass through the through hole **24**. In this case, it is arranged that a part of the opening of the through hole **24** is not covered.

The semiconductor chip **10** is bonded face-down to the substrate **20**. For the electrical connection of the electrodes **12** and interconnecting pattern **22**, an insulating resin bond (for example a bond using NCP (non-conductive paste), NCF (non-conductive film), or the like), an anisotropic conductive material bond (for example a bond using ACF (anisotropic conductive film) or the like), an alloy bond (for example Au—Au or Au—Sn bond or the like), a solder bond or any suchlike known bonding method may be applied.

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The semiconductor chip **10** and substrate **20** may be fixed with an adhesive **14**. The adhesive **14** is provided to reach the side surface of the semiconductor chip **10** (the surface upright to the surface on which the electrodes **12** are provided). It should be noted that the adhesive **14** may be provided to the same height as the upper surface (the surface opposite to that on which the electrodes **12** are provided) of the semiconductor chip **10**, or may be provided to a position lower than the upper surface. The adhesive **14** may be such as to absorb moisture more easily than a sealant **36**. The adhesive **14** may be NCP, NCF, or ACF.

As shown in FIG. 1A, the substrate **20**, with the semiconductor chip **10** mounted thereon, is disposed on a lower die **32**. The surface of the substrate **20** opposite to that on which the semiconductor chip **10** is mounted contacts the lower die **32**. On the upper part of the semiconductor chip **10** (more precisely the surface of the semiconductor chip **10** opposite to that of the substrate **20**), a film **34** is disposed. The film **34** is flexible. The film **34** is formed of a resin. For example, this resin may be a fluorine-based resin. On the film **34** is disposed an upper die **30**. The film **34** may be adhered to the upper die **30**. As the upper die **30** and lower die **32** can be used the dies of a transfer mold device.

As shown in FIG. 1B, the semiconductor chip **10** and substrate **20** are sandwiched by the upper die **30** and lower die **32**. Between the semiconductor chip **10** and the upper die **30** the film **34** is interposed, and the semiconductor chip **10** is pressed into the film **34**. A part (the upper extremity) of the adhesive **14** (more precisely, the adhesive **14** provided on the side surface of the semiconductor chip **10**) may be pressed into the film **34**. By this means, the upper surface of the semiconductor chip **10** can be covered by the film **34**. A part of the adhesive **14** can be covered by the film **34**. Furthermore, a part of the side surface of the semiconductor chip **10** (the upper extremity of the side surface) may be covered by the film **34**.

As shown in FIG. 1C, between the upper die **30** and lower die **32** the sealant (for example a transfer mold resin) **36** is provided. The sealant **36** is provided on the surface of the substrate **20** on which the semiconductor chip **10** is mounted. In more detail, the sealant **36** is provided between the film **34** and the substrate **20**. Since the film **34** is pressed into the semiconductor chip **10**, the sealant **36** can be provided so as not to cover the upper surface of the semiconductor chip **10**. If a part of the adhesive **14** is pressed into the film **34**, the sealant **36** can be provided so as not to cover a part of the adhesive **14**. The sealant **36** is provided around the semiconductor chip **10**.

By means of this, since the sealant **36** is provided when the film **34** is pressed into the semiconductor chip **10**, the sealant **36** is lower than the semiconductor chip **10**, and it is easier for water vapor to escape from the interface between the sealant **36** and the semiconductor chip **10**. Therefore, when the semiconductor device is mounted on a circuit board, the resistance to reflow processes is improved. If the adhesive **14** is exposed, the water vapor can more easily escape therefrom, and the resistance to reflow processes of the semiconductor device is improved. If the semiconductor chip **10** is made thinner, it becomes simpler to make semiconductor devices thinner. Furthermore, since the semiconductor chip **10** does not directly contact the upper die **30**, but contacts the film **34**, chipping or cracking can be avoided.

As shown in FIG. 2A, the semiconductor chip **10** is removed from the upper die **30** and lower die **32**. The film **34** may be of a nature to be more easily peeled from the sealant **36** than from the upper die **30**. When the film **34** is peeled from the semiconductor chip **10** and sealant **36**, a part

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of the upper surface of the semiconductor chip **10** and adhesive **14** is exposed by the sealant **36**. As shown in FIG. 2B, the substrate **20** and sealant **36** may be cut. Furthermore, as shown in FIG. 2C, if required, external terminals (for example solder balls) **38** are provided. The external terminals **38**, achieving for example electrical connection through the through hole **24**, may be provided on the interconnecting pattern **22**. In this way, the semiconductor device can be manufactured.

The semiconductor device of this embodiment includes the substrate **20** and the semiconductor chip **10** bonded face-down to the substrate **20**. The substrate **20** and semiconductor chip **10** are adhered by the adhesive **14**. The adhesive **14** is provided to reach the side surface of the semiconductor chip **10**. On the surface of the substrate **20** on which the semiconductor chip **10** is mounted, the sealant **36** is provided around the semiconductor chip **10**. The sealant **36** is provided to expose the upper surface of the semiconductor chip **10** and a part of the adhesive **14**.

According to the semiconductor device of this embodiment, the substrate **20** is reinforced by the sealant **36**, and the coplanarity of the external terminals **38** can be assured. This sealant **36** has the advantage of being less expensive than a metal stiffener. Since the upper surface of the semiconductor chip **10** (more precisely, the surface opposite to that of the substrate **20**) is exposed by the sealant **36**, the heat dispersion is excellent. Furthermore, since the sealant **36** can be provided so as to expose a part of the adhesive **14**, water vapor can be allowed to escape from the adhesive **14**.

In the above described method of manufacturing the semiconductor device, the sealant **36** is provided to expose a part of the adhesive **14**, but the method of manufacturing a semiconductor device of the present invention does not exclude the case in which, as shown in FIG. 3, a sealant **40** is provided to cover the whole of the adhesive **14**.

FIG. 4 shows a circuit board **1000** on which is mounted the semiconductor device **1100** shown in FIG. 2C. As electronic instruments having the semiconductor device shown in FIG. 2C, in FIG. 5 a notebook personal computer **2000** is shown, and in FIG. 6 a portable telephone **3000** is shown.

The present invention is not restricted to the above described embodiments, and various modifications are possible. For example, the present invention includes substantially the same construction as the construction described in the embodiment (for example, a construction for which the function, method, and result are the same, or a construction of which the purpose and result are the same). The present invention includes a construction in which parts which are not of the essence of the construction described in the embodiment are replaced. The present invention includes a construction having the same effect as the construction described in the embodiment or a construction capable of achieving the same purpose. The present invention includes a construction having the construction described in the embodiment to which is added well-known art.

What is claimed is:

1. A method of manufacturing a semiconductor device comprising:

- adhering a semiconductor chip to a substrate by using an adhesive, and
- providing a sealant around the semiconductor chip, on a surface of the substrate on which the semiconductor chip is mounted,
- wherein the adhesive is provided to reach a side surface of the semiconductor chip, and

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wherein the sealant is provided in a manner to expose an upper surface of the semiconductor chip and a part of the adhesive, and

wherein a film is disposed on the semiconductor chip adhered to the substrate, an upper die is disposed over the film, a lower die is disposed under the substrate, the semiconductor chip and the substrate are sandwiched by the upper die and lower die, the semiconductor chip is pressed into the film, and the sealant is provided between the film and the substrate.

2. The method of manufacturing a semiconductor device as defined by claim 1,

wherein the semiconductor chip and the substrate are sandwiched by the upper die and lower die in such a manner that a part of the adhesive is pressed into the film.

3. The method of manufacturing a semiconductor device as defined by claim 2,

wherein the film is more easily peeled from the sealant than from the upper die.

4. The method of manufacturing a semiconductor device as defined by claim 1,

wherein the film is more easily peeled from the sealant than from the upper die.

5. A method of manufacturing a semiconductor device comprising,

adhering a semiconductor chip to a substrate, and providing a sealant around the semiconductor chip, on a surface of the substrate on which the semiconductor chip is mounted,

wherein a film is disposed on the semiconductor chip adhered to the substrate, an upper die is disposed over the film, a lower die is disposed under the substrate, the semiconductor chip and the substrate are sandwiched by the upper die and lower die, the semiconductor chip

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is pressed into the film, and the sealant is provided between the film and the substrate.

6. The method of manufacturing a semiconductor device as defined by claim 5,

wherein the film is more easily peeled from the sealant than from the upper die.

7. The method of manufacturing a semiconductor device as defined by claim 5,

wherein the semiconductor chip is adhered to the substrate with an adhesive, a part of the adhesive positioned next to a side surface of the semiconductor chip, wherein the semiconductor chip is pressed into the film so that the film touches the part of the adhesive next to the side surface of the semiconductor chip.

8. A method of manufacturing a semiconductor device comprising;

adhering semiconductor chip to a substrate by using an adhesive, and

providing a sealant around the semiconductor chip, on a surface of the substrate which the semiconductor chip is mounted,

wherein the adhesive is provided to reach a side surface of the semiconductor chip, and

wherein the sealant is provided in a manner to expose an upper surface of the semiconductor chip and a part of the adhesive, and

wherein the adhesive consists of its first, second and third parts, the first part positioned under the semiconductor chip, the second part positioned around the semiconductor chip and covered with the sealant, the third part positioned next to the side surface of the semiconductor chip and exposed from the sealant.

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